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THE CULTIVATION OF MAIZE AT THE CAWNPORE EXPERIMENT STATION.

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Cultivation of Maize at the Cawnpore Experiment Station.

During the past 19 years maize has been one of the crops that have been regularly studied and experimented on at the station. Since 1895 outturns ranging from 30 to 35 maunds of grain have been repeatedly obtained on a number of plots, and occasionally as much as 40 maunds and more, and what is of greater importance definite knowledge has been gained of the conditions which are essential for these higher outturns. The object of this bulletin is to give in a popular form brief descriptions of the processes which have rendered such outturns possible at the Cawnpore Station and which if followed by the agriculturist in North India must lead to more or less similar results and thus materially increase the food-supply of the country. The following table gives the yields obtained during these 19 years on a certain number of plots which have been permanently set apart for experiments with maize.—

By glancing over the figures of the several plots from top to bottom of the table it will be seen that the outturns since 1895 have been generally speaking higher and more uniform, *i.e.*, less affected by the vicissitudes of climate. This point is clearly brought out in the averages for the three periods given in the table. In the case of every one of the plots the average for the six-year period ending 1900 is higher than that for the five-year ending 1894 or of that for the period ending 1889. To bring to our minds more clearly the full extent and value of this increase, and then to carry on our enquiry of finding out the causes for it, let us concentrate our attention on the quinquennial averages of the three cattle-dung plots of the standard series alone. They are as below:—

Acreage outturns of maize grain on cattle-dung plots.

	Standard No 3	Standard No 1.	Standard No 2	Average of the three plots	Remarks
	lbs	lbs.	lbs	lbs	
Average for five years ending 1889	1,211	1,442	1,281	1,305	For our present purpose in this table there is practically no harm in assuming that all these three plots have been manured with equal quantities of cow-dung
Average for five years ending 1894	936	1,305	1,471	1,237	
Average for ten years ending 1894	1,103	1,372	1,366	1,281	
Average for six years ending 1900	2,276	2,358	2,472	2,369	
Increase of the average of the six years ending 1900 over that of the ten years ending 1894	1,172	986	1,106	1,088	

Thus taking the average of these three plots, the produce during the six years ending 1900 has been on the average about 1,000lbs of grain per acre more than that obtained before. Not less important than this increase of outturn is the much smaller extent to which the vicissitudes and uncertainties of the season have been affecting the crop, as a perusal of the table will show. These discordant results not only frustrated the objects of the experimenter but led one to think

that maize was an uncertain crop, and that it would be a risky matter to spend money on it in the shape of manuring, &c., whereas the experience gained since 1895 has demonstrated that under intelligent cultivation and favourable conditions of soil and irrigation maize is a certain crop, and at least as hardy and reliable as any other *kharif* cereal, and very much quicker-growing and more productive.

This difference in the results was due to the fact that the method of cultivation adopted for the crop before 1895 was like that given by the ordinary cultivator, and since that year on altogether different lines. Below are given the several operations and processes which have enabled us to secure these results.—

1 *Sufficiency of space for each individual plant.*—This is absolutely essential in order that the roots may be able to develope and go about freely for getting food from the soil and the stem and leaves may have abundance of light and air. The area requisite for each plant to get the largest possible produce of grain out of a field varies with the soil, the variety, climate, &c. For the ordinary orange-coloured country variety not less than 1½ square feet, and for the larger light yellow-coloured variety equally common in certain districts of the provinces not less than 2 square feet, should be allowed on fields now usually devoted to maize by the cultivator. On richer lands, as on the garden soil near towns, or when manured with the more stimulating manures as castor cake, poudrette, &c., or with large quantities of cattle-dung, as much as 2 square feet for the former smaller variety and 3 square feet for the latter larger variety may be allowed. When the plants happen to get less room than noted above, they get crowded, weak and pale and show the effects not so much in the quantity of stalks and leaves produced as in the number and size and filling of the cobs, *i.e.*, the outturn of grain will fall more and more in proportion to the crowding. The great evil in the ordinary maize crop of the cultivator, and it may be said also in the maize crop of the Cawnpore Station before 1895, is *over-crowding*. If this single point be properly attended to the outturn of maize grain can be increased by 25 to 50 per cent., all other conditions of the cultivator's crop remaining the same.

a row. The richer the field, or the more adverse the season, the greater the benefits of this improvement.

Essential as this condition of right space for each plant, i. e., neither more nor less, is for outturns like 30 and 35 maunds per bore, still more does it become a determining factor when larger yields than these amounts are aimed at. For while over-crowding starves and weakens the plants, and thus incapacitates them from producing as much as a smaller number of better fed and more vigorous plants can, more room than what has been prescribed above will on the other hand lead to a waste of land. the individual plants in this excess of room will develope better and yield more grain than those getting the space recommended: but the total amount of grain produced by the smaller number of plants in the former case will turn out lower than that produced by the larger number of plants of the latter case, inferior though these may be individually, that is, in a practical point of view, for getting the largest produce of grain out of a given area, deviation from the above limits on either side will be found, in the forcing climate of North India, not an improvement but probably the reverse. Some figures bearing on this point are given in Appendix II.

To secure this condition the practice at the Cawnpore Station has been to mark out, with the help of a rope and two sticks, straight lines on the field, both lengthwise and breadthwise, at the requisite distances, and then to dibble seed by hand in holes made with the *khurpi* (hand-hoe) at the points of intersection. By this means 2 feet between row to row and 1 foot between the plants in the rows has been the aim, though not always secured owing to the technical difficulty of not being able to get with our present contrivances and labourers the holes made just at the right points. This difficulty has been latterly got over at the Cawnpore Station by giving instructions for dibbling at smaller distances than what is really aimed at, and when the work is finished and the plants come up and are counted the actual number will turn out to be somewhat fewer than what was originally contemplated. When the aim is 2 feet by 1 foot, the instructions will be for, say, 1½ feet by 9 inches. This business of hand-dibbling may perhaps, to those who

have not tried it, look a bigger and costlier affair than what they will find it to be actually after they have made one or two practical attempts. In fact it is a simple matter and has been done at the Cawnpore Station by ordinary labourers every year during the past six years on a number of fields. Three men for marking the lines and four or five women with *khurpis* for making holes and dibbling three or four seeds in each hole are sufficient for the work. Sometimes the straight lines are marked on the field in one direction, and for making holes in the lines the women are provided with small sticks a foot in length or as the case may be, and they measure the distance and then dibble the seed. The cost of dibbling 2 feet by 1 foot comes to about Re 1 an acre.

To give each plant the requisite area, the seed may also be dropped in the furrows made by the country plough, leaving one or two furrows blank. But the practical difficulty in adopting this simpler method is at the time of thinning. the furrows and the seed dropped in them not being in straight lines, the distance to be allowed between the plants on the field varies, and cannot be even approximately worked out by labourers. So the thinning done gives spacings different from those contemplated, in one case more, and in another less, and so on, whereas in the case of hand-dibbling at regular distances apart all that the labourer has to do when the crop is about seven to ten days old, is to leave one vigorous plant in each hole and pull out all the rest. Subject as the former method is to the disadvantage noted, it may be the only one practicable where labour is scarce. To show what results may be expected from it, it may be mentioned that many of the yields obtained in 1895 and 1896 were got by adopting this plan of sowing. If other conditions are favourable even better results may be expected, for in those two years, and more so in the earlier year, the thinning was not based on a clear knowledge of how much space should be allowed to each plant for our conditions, and therefore erred on the safer side of allowing too many plants on a given area.

From these remarks it must be obvious that the system of broadcasting maize seed by hand common in certain districts is one that should disappear.

2. *Sub-soiling.*—Sub-soiling once to a depth of about 9 or 10 inches is an invariable practice at the Cawnpore Station in preparing the land for maize. There is little doubt that a good deal of the success attained with maize, as with most other crops, is due to this operation. At the station sub-soiling is effected by one mould-board plough going in front followed by another heavy plough with the mould-board removed working in the furrow made by the former plough, so that if the first goes down 5 inches deep, the second begins at the fifth inch and cuts about 4 inches more, a total depth of about 9 inches is secured. The cost of this operation comes to about Rs 3 an acre. The ordinary cultivator not being able to adopt this plan for want of implements can, if labour be available, have his land dug with the *phaora*, which may cost him about Rs 5 to Rs 7 per acre.

When either of these two plans is not adopted, as will frequently be the case, ploughing as deep as possible with the native plough may be aimed at. If the soil be rich or well manured, and if each individual plant gets sufficient space, up to about 30 maunds per acre are within reach of the cultivator even in the absence of sub-soiling or digging with the *phaora*.

3 *Varieties and selection of seed.*—About 18 varieties of American maize and the two common North Indian varieties have been tried at the station with a view to test their merits as regards hardihood, productiveness and suitability to the climate of North India. The results of these trials showed that American varieties could be grown without any difficulty the same year the seed was imported; that one or two Americans might excel the Indians in productiveness, that taking everything into consideration the two country varieties are the best for our present local conditions; that much better practical results could be immediately achieved by improving these two varieties by a careful selection of seed, &c., and that with the light yellow country variety as improved at Cawnpore the best results that the North Indian climate and soil would admit of might be attained within a few years.

But a careful selection of seed by the farmer is a necessity if he wants full yields. The simplest way for him to do this is to

walk over his field when the crop is ripe, select all the vigorous plants that bear two good cobs, cut these plants first and bring them over to his threshing floor, keep them there carefully, and then go on with the harvesting of the remainder of his crop as usual. When he has some leisure and is free from other work he should examine these selected plants and take the larger of the two cobs to preserve as seed for next year. If this be done for a few years he will be agreeably surprised to see how the number of two cobbed plants on his fields and the amount of their produce are increasing year after year. For persons of education and leisure who would like to carry on the work of seed selection more scientifically with the object of supplying improved seed to the public further details and notes are given in the appendix.

4. *Manuring.*—Maize is a quick grower and at the same time a gross feeder, because it is a heavy producer. To get good results from maize either the land should already be in good manurial condition or it should be liberally manured. When neither is the case, *juár* or *bájra* according to the soil will, as being slower growers, be found to yield better results. If the other conditions noted in this bulletin are secured for the crop, then on most lands now put under maize in North India an application of up to 100 maunds of cattle-dung or poudrette or 10 maunds of castor cake will be more than repaid in the increase of outturn. But the less and less these other conditions are satisfied, the lower becomes the limit of production and the greater the risk from the vicissitudes of the weather, and in such cases greater expenditure on manures will become risky, so far as the immediate results of that season are concerned. For there is always the fact (so well known to all practical agriculturists) to remember that organic manures like the substances we commonly use in India are never lost suddenly, but show their effects over a series of years, and consequently that portion of the manure which was prevented from showing its effects during that crop practically lies in the field awaiting the advent of the next crop. The manures applied after 1899 to the several plots shown in table No. I above afford materials to ascertain individually according also the quantities and kind of manure they should

apply to suit the conditions under which they are working In the next table also are given the yields obtained with different manures from potatoes and maize on land that may be taken in quality equal to the better situated maize fields of the villages The manures shown in the table are applied only before planting the potatoes, and on the residue of manure left unutilized by this crop the maize is grown.

TABLE No II.—*Acreage outturns of potatoes and maize obtained with different manures at the Cawnpore Experiment Station.*

Number	Manure applied per acre. Quantity.	Approximate value	Potatoes. 1896-1897	1897-1898	1898-1899	1899-1900	1900-1901.	Average of 5 years, 1896-1900	Maize grain. 1897	1898	1899	1900.	Average of 4 years, 1897-1900
		Rs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
1	Unmanured		2,880	6,600	7,860	18,710	6,915	8,993	3,180	3,920	1,100	2,720	2,217 5
2	Poudrette supplying 100lbs nitrogen, i e about 20,000lbs or 250 maunds	13	5,700	9,780	9,170	17,070	12,365	10,807	3,205	2,440	17 88	3,690	2,752
3	Cattle dung supplying 100lbs nitrogen, i e, about 20,000lbs or 250 maunds	13	9,200	7,340	9,110	15 010	9,775	10,295	2,955	1,720	1,040	2,915	2,167 6
4	Castor cake supplying 100lbs nitrogen i e, about 1,500lbs or 20 maunds.	25	8,150	10,280	11 610	15,100	15,010	12,056	3,633	1,910	1,240	3,780	2,115 7
5	Saltpetre and bone dust each supplying 50lbs nitrogen, i e. saltpetre 150 to 600lbs or 3¼ to 7 maunds and bone dust	40 to 50	7,960	9,200	13,500	16,920	10,180	11,572	3,958	3 270	1,705	2,870	2 425 7
6	Saltpetre supplying 50lbs nitrogen, i e, 150 to 600lbs or 3¼ to 7 maunds	27 to 35	6,780	10,000	7,160	15,700	11,830	10,286	3 045	1,980	1,260	2,820	2,275 7
7	Unmanured		4 080	8 110	2 900	9 870	5 4 0	086	3 005	1 840	988	2 790	2 0 3 0
8	Average of the 5 unmanured plots		6 0 0	7 430	5 38	1 Ga	6 192	5 5 5	3 067 5	1 880	1 01	2 850	2 15 3

A perusal of this table reveals the amount of food that can be produced on a given area in a year under favourable conditions of tillage, manuring, irrigation, &c.—conditions the like of which the *major portion of the area now devoted to* maize in North India may be taken to possess. In this connection it should be noted that the belief vaguely entertained by some that potatoes are fitted only for the vicinity of large towns and not for villages is not based on any practical experience or knowledge of the crop how much it produces, how the crop yields abundance of food at, to the cultivator, a most critical part of the year, *i. e.*, in January and February, and how particularly valuable this point is in years of scarcity and famine, is fully known only to *those who have had opportunities* of noticing the avidity with which labourers rush to buy the crop when dug out of a field.

Irrigation.—In the majority of cases the North Indian *cultivator* is prepared for and does give a watering or two if the crop shows the need for it during the breaks in the rains. The value of this watering rises in *proportion to the quality of the* crop, and in eight or nine years out of ten it may be assumed that a watering or two for maize is a paying investment of money and is, in conjunction with the regular spacing of the individual plants, the factor that makes maize the most certain of all the *kharif* cereal crops.

Digging and hoeing.—At present the cultivator as a rule hoes and weeds his maize once or twice, and earths up his plants to give them a safe anchorage. If in addition to these he will try shallow digging between the crop with forks or *kudahs* once, and better still twice, and observe carefully the results obtained, the chances are he will never regret the trouble he took, nor will he need to be advised to do the same in subsequent years. At Cawnpore this digging, which, when done on contract, costs Re. 1-9-0 an acre, has been found a powerful agent for stimulating the growth of the crop and conserving moisture in the soil, and has been invariably more than repaid in the increase of outturn.

General remarks.—In this section of the bulletin only those points have been noticed on which the present general notions are not quite clear or correct, and not points like the selection of suitable land for maize, the time of sowing, &c., which the ordinary cultivator understands clearly enough. To secure full yields from maize—

(1) he must first give up the idea that 15 to 20 maunds of grain per acre is an exceptionally good crop;

(2) he should know that in other countries yields of 50 to 80 maunds per acre are frequently obtained over large areas, while there are not a few records of yields like 100 maunds and more with the crop taking 5 to 5½ months to mature,

(3) that at Cawnpore yields of 30 to 40 maunds have been repeatedly obtained in about half this time,

(4) that to secure yields approaching Cawnpore ones the agents at his disposal are—

(*a*) regular spacing of each individual plant,

(*b*) selection of seed or using Cawnpore maize seed,

(*c*) two diggings between the crop in addition to the usual weeding and earthing,

(*d*) one or two waterings during the breaks in the rains that occur in most years,

(*e*) liberal manuring

(*f*) rather deep ploughing or digging with *phaora* before sowing.

The cost of cultivation of maize per acre is shown in the following table the figures for ordinary cultivation are mostly reproduced from "Field and Garden Crops" (page 23, Volume I), but the prices have been altered in some cases to bring them into accord with existing facts :—

Operation.	Ordinary cultivation.		Cawnpore cultivation.		
	Total cost			Total cost	
	Rs. a. p.			Rs. a. p.	
Ploughing 4 Clod crushing 1	3 1 0		Sub-soiling 1 Ploughing 2 Crushing with cultivator 1	6 0 0	
Seed & sêra	0 6 0		15 sêrs ...	1 0 0	
Sowing	0 14 0		by dibbling ..	1 7 0	
Thinning ..			1	0 10 0	
Weeding and hoeing 3	3 0 0		2	8 0 0	
Earthing .	1 4 0		1	2 13 0	
Digging between rows			2	3 2 0	
Watering { canal dues ... / labour .			1 {	1 8 0 1 5 0	
Lifting and tying fallen plants				1 5 0	
Watching ..	0 13 0			3 0 0	
Harvesting and shelling ...	2 1 0			3 8 0	
Manure (half value), 3 tons ..	2 1 0		4 tons ..	2 12 0	
Total .	13 13 0		Total	31 12 0	
Normal produce, 13 maunds at Re 1 12 0	22 13 0		35 maunds, at Re 1 12 0	61 4 0	
Profit (out of which rent has to be paid)	8 15 0		... .	29 8 0	

Such calculations can only be approximate, as a matter of fact the cultivator's cash profit is greater than is shown above, as most of the labour is done by himself and his family, while the hire charged for cattle is probably more than their keep, &c., costs on the average. But for comparative purposes the figures are of value, and it is important to remark that most of the extra cost at Cawnpore is incurred for labour, so that if a cultivator has time and energy to follow the Cawnpore methods he can obtain the larger produce at a less increase of cost than is shown in the table, that is the rise in his cash profit will be greater than is shown.

Having examined at some length the more important factors that go to make maize a certain and productive crop, we may

here notice a few other points that are also of some interest and practical importance —

1. In table No I-it will have been noticed that the yields of the standard plots since 1895 have been generally higher than those of the corresponding alternate plots This point is clearly brought out in the averages for the six-year period ending 1900. The reason for this difference has also been seen to be that on the standard plots maize follows maize after a fallow of nine months, while on the alternate plots maize follows wheat after a fallow of only three months. These figures simply put in a definite form what is generally known to practical agriculturists and others who have observed the crops in the country But it will not pay to leave a part of the richest land of the holding of a farmer fallow for nine months in the year, as is done in the experiment of the Cawnpore Station, which is not meant for his imitation in that very form but for other objects To the more enterprising and better circumstanced few the following rotations can be recommended —

(i) 1st year *rabi*—Potatoes after manuring
2nd year *kharif*—Maize with no manure
3rd year *rabi*—Gram ditto
3rd year *kharif*—Maize ditto
3rd year *rabi*—Potatoes after manuring

(ii) 1st year *kharif*—Maize and cotton in alternate rows with manuring
2nd year *kharif*—*Jadr* for fodder (if possible to be fed on the land) without manure
2nd year *rabi*—Potatoes

To the majority who may not care to potatoes the following rotations can be recommended —

(iii) 1st year *kharif*—Maize with manuring
1st year *rabi*—Peas or gram (if possible to be fed on land by cattle) without manuring
2nd year—Maize and cotton in alternate rows without manuring
3rd year—Wheat without manuring, but with thorough tillage
4th year *kharif*—Maize with manuring

(iv) 1st year *kharif*—Maize without manure

1st year *rabi*—Peas to be ploughed in or to be fed by cattle on the land.

2nd year *kharif*—Maize.

(v) 1st year *kharif*—Gwar for fodder to be fed on the land without manure

1st year *rabi*—Gram for grain ditto ditto.

2nd year—Maize and cotton without manure

Similarly any number of suitable rotations can be worked out to suit varying individual circumstances

In drawing up schemes of rotation the points that may with advantage be borne in mind are (1) that of the four or five more important crops—potatoes, sugarcane (for crushing), wheat, cotton, and maize which will claim one's attention with reference to the immediate application of the manure available, it will under present conditions pay better to give preference to potatoes over all other crops, (2) that the crop that follows potatoes, whatever it be, will generally be good on account of the excellent mechanical and clean condition to which the land gets reduced during the growth of the crop and while digging it out; (3) that when *potatoes are not in the list*, then it will pay best to apply the manure to maize in preference to the other three crops, because *sugarcane wants richness in the land supplied by organic manure* at least five or six months ago, and because the slower-growing wheat and cotton are less exacting than maize and can be *made*, by good tillage, to yield remunerative returns unlike maize. For particulars regarding the cultivation of maize and cotton in alternate rows see bulletin No 15 of 1901 on the cultivation of longer stapled cottons issued by this Department. The point that is meant to be shown in the suggestion of the last three rotations is that there are other better ways of making the most of the land *than by taking* maize and wheat or wheat-barley in succession, as is done in some places Certainly the practice prevailing in the better class of villages, as *those of Jats in* Muzaffarnagar, of growing maize and gram in rotation is much better, both as regards immediate profits and the effect on the land.

2 In sowing, whatever be the system adopted, whether hand-dibbling or dropping the seed in the furrows made by the native plough, it is safer, and on the whole more advisable, to use more seed than less. The seedlings pulled out during thinning make a splendid fodder for cattle and for horses where kept, worth in value more than the extra seed used. It may be noted that in 1896 when 30lbs seed per acre was dropped behind the native plough, in the thinning done about a fortnight to three weeks after sowing the seedlings removed weighed at the rate of 400lbs per acre.

3 *Maize straw.*—Throughout these provinces and in such places of Madras as grow maize the straw is generally considered useless as fodder for cattle and thrown away; but on the other hand in America, the original home of maize and the country which grows it on the largest scale, the straw is very much valued as fodder, just as *jadi* straw is in this country Leaving alone the hasty condemnations sometimes passed on the cultivator for this apparent wastage of what is considered a valuable article in another country, there is little doubt that cattle here do not like the stuff and avoid eating it so long as they can help it, and in this reluctance mere habit is not the chief cause but probably the unpalatable nature of the article itself At the Cawnpore Station some trials were made in feeding cattle with the straw, and the results of the trials are that by chopping into small pieces with the *gadhasa* or chaff-cutter and mixing with the chaff of other fodders, and persisting for a few days, the cattle can be induced to eat the leaves and a part of the stalks, that something more of this article can thus be made as fodder by the cultivator, whose one great want is more fodder for his cattle, than he does now, that in this way at least something bulky to fill their stomachs is rendered available which, when liberally supplemented by concentrated foods as cotton seed, oil cakes, &c, appears to maintain the animals in the condition they were before this mixture was begun, that when the stalks and leaves are somewhat green and not quite dry they are more readily eaten, that when unsupplemented by concentrated foods, as is often the case with cattle of the ordinary cultivator, N rth dia maize straw can ak th place and wil n no wa adm o com w the N aw ud when &c

o is for this difference in the nutritive qualities of
d Indian maize straws appear to lie in the fact that
nd a maize matures in 75 to 90 days, while in
al es about 4½ to 5½ months to mature; that when
well formed the stems and leaves are exhausted of
t in them probably more thoroughly in India than
that with *juár* crop it is practically known in certain
he straw of *juár* which is grown under well irrigation
in about three months is inferior and has a lower
fodder than the straw of *juár* grown in the proper
n fed lands and taking about five months to mature;
neal experience of the cultivator and the teaching
ave fixed a lower value to the straws of cereals as
dhan), *juár*, &c, produced by crops which have
ourtions of grain than to those of the same crops
o adverse weather or other reasons, have not matured
The following table shows the inferiority of the
s where the cobs showed exceptional development —

III —*Proportion of straw to cobs in unusually double-cobbed maize plants, &c, grown at the me Station in* 1899

We ht of cob p it	Weight of the two cobs with their sheaves and stalks	Weight of the straw alone without the cobs	Percentage of cobs to the plant	Weight of the stalks and sheaves of the cobs
Oz	Oz	Oz		
25	14½	10½	58	Included in the straw
23¼	15½	8	65	2½ oz
18	13½	4⅞	73	1½ „
22½	16½	7	69	1⅝ „

the cobs or the straw were stated either by at the time of threa

Of course the only satisfactory way of deciding a question like this is to carry on systematic feeding experiments on cattle with maize straw side by side with *juár* and other straws, keeping records of the weights of the animals at the several stages of the experiment in conjunction with chemical analyses of the fodders. And in the absence of such experiments these figures can but throw indirect light on the question.

Regarding the value of green maize fodder for cattle, it requires no saying that it has been extensively used on the Cawnpore Station for working cattle with excellent results, and for producing abundance of nutritive green fodder in one-and-a-half to two months' time maize has no equal, not even our *juár*.

4 *Maize grain as food for cattle and horses.*—During the past five or six years, not only for cattle but for the horses belonging to the riding club of the Agricultural School and for private horses maize has been largely used as food instead of gram during the period from September to March, when it sells cheaper than other grain suited for animal consumption. The grain is broken to pieces in a grain-crusher and soaked in water a few hours before use for cattle, and just mixed with a little water at the time of using for horses. In the case of the latter, to avoid a sudden change of food, maize can be substituted for a part of the usual allowance of gram, decreasing the gram gradually to one-third the weight of the maize when the animals are not hard-worked and where economy is a chief consideration and to half-and-half in other cases. Native breeders of horses in the provinces and owners of cattle will find that by this method the cost of feeding during five or six months in the year can be reduced by about 10 to 15 per cent. Maize as food for all kinds of livestock is greatly valued in America, and is largely produced for this special purpose.

Varieties.—As has been already remarked a number of varieties have been tried at the Cawnpore Station during recent years, and the following notes of results may be given here as having some positive and negative value. The sketches given a few pages further on show the actual sizes of typical cobs produced at Cawnpore.

Deep yellow country maize.—This is the variety commonly grown by the cultivators in Cawnpore and the adjoining districts, and appears to be more or less common throughout the provinces. It is very much like, if not identical with, the country variety grown in the few places of the Madras Presidency where maize is grown to any extent. The plants are about 4 to 7 or 8 feet high, bear cobs about a foot to a foot-and-a-half and rarely more than 2 feet high from the ground, and on account of this last quality and their firm anchorage stand winds and storms fairly well, they mature in about 70 to 80 days. The cobs are small and have grain closely and compactly set. The grains are hard, of a bright deep yellow or orange colour, rounded or oval in appearance, give good flour and command the best price in places where this variety is more common; and for keeping qualities this variety is one of if not the best. This hardy permanent variety of poorer lands has on the whole many qualities which go to contribute to its popularity, and will admit of considerable improvement by selection of seed.

Light yellow country maize.—This variety is more common in Meerut, Muzaffarnagar and that neighbourhood, and in Jaunpur and probably also in its adjoining districts. It appears to represent the type belonging to richer lands or better cultivators, such as the Jats of the Meerut division, and is more popular probably near all the larger towns of the provinces where maize is grown on garden lands for selling green cobs. It has larger and taller plants, being about 7 to 10 feet high and on good lands going up to 12 feet, a luxuriant growth with longer and larger leaves, bears good-sized cobs about 2½ to 3 feet high from the ground, is more susceptible to high wind, especially after rainfall or irrigation, and takes about 80 to 90 days to mature, *i.e.*, about 10 days more than the former variety. On account of these qualities, and on account of the comparatively lower order of soils and circumstances that prevail in the districts where the deep yellow maize suits better, this variety is not so common, but in the other places referred to its decidedly greater productiveness renders it more popular.

The grain is larger; of a light yellow or straw colour often duller than the smaller variety, yields flour practically as good as

the former; fetches in places where the other variety is common a slightly lower price, about a sér more for a rupee, but in places where this variety is the common one as good a price as, if not better, than the orange variety. Its grain is comparatively less hard, and in keeping qualities perhaps slightly inferior to the other variety; but for all practical purposes any inferiority that may exist in this respect is not likely to oust it from places where its greater productiveness is appreciated and preferred.

This is the variety that is commonly referred to in the reports of the Cawnpore Station and other official papers as the Jaunpur variety because of the fact of its seed for use at Cawnpore having been originally obtained from Jaunpur

When patiently and carefully improved by selection of seed and good cultivation, it can be made to match, and even excel, the majority of the American varieties for our local conditions and requirements, and is on the whole a variety full of promise. It is the standard variety used for all experimental purposes at the Cawnpore Station An improved strain of this variety is available from Cawnpore for those who apply for its seed in time. The Cawnpore improved light yellow variety may generally be expected to yield cobs about 20 to 30 per cent larger in size and as much greater weight of grain than the same variety in its ordinary form as met with in Jaunpur or Meerut side The yields shown in the several tables of this bulletin have, except where otherwise specially mentioned, been obtained from this improved light yellow variety

American varieties—It is beyond the scope of this bulletin to enter into a detailed description of the several American varieties that have been tried at Cawnpore But it will be of interest and importance to know their common characters and the points in which they generally differ from ours, both on the favourable and on the unfavourable side. The American maizes can be broadly divided into—

(1) Dent corn (corn is the common term in America for maize).
(2) Flint corn
(3) Pop corn.
(4) Sweet corn or sugar corn

Of these the last two are intended for the table; the pop corn after popping, and the sweet corn for using green after boiling or roasting. The grain of the last is shrivelled, wrinkled, hard, horny and translucent in appearance, due to the starch having been more or less reduced to glucose, a form of sugar. About 20 varieties of sweet corn have been tried, and no difficulty has been experienced in growing them, one special feature of these plants being their greater tendency to tiller, to be prolific of cobs, and to be shorter in height. The pop corn has not been tried at Cawnpore, but to judge from its description, as elongated oval in outline, extremely hard, &c, must be like our deep yellow country variety, which also pops well, *i. e.*, makes good *phoota* (or *phori* in Tamil). Both these classes are not regular field crops, and do not therefore need further attention for our present purpose

Dent corn appears to contribute the largest number of varieties of field-maize, and the accompanying drawing is of what may be taken as a fair type of dent corn. As will be seen from the drawings the grains or kernels are indented on the top, large, deep and more or less wedge-shaped Those of flint corn are hard, smooth and more or less oval like those of the two Indian varieties, and more especially the light yellow one already described The strikingly good features in all the dent varieties with which the Americans generally obtain their wonderfully heavy yields are the largeness and depth of the individual grains, the almost cylindrical shape of the cob, so that it may hold the largest proportion and weight of grain, and the straightness or regularity of the rows The bad points are their indentedness, general tendency to be of dull colour, yielding inferior flour or meal, and their general unattractive appearance when presented in the market; and in consequence of these points the dent corns fetch in American and European markets a lower price, and will in Indian markets fetch still lower prices, as here the great and almost only purpose is, unlike in America and Europe, for making flour or meal for human consumption. The flint varieties stand midway between the Indian varieties and the American dent corns in these favourable and unfavourable characters. The colour of these Americans varies greatly. The ideal colour is bright yellow which fetches the highest price in the West also.

Those who produce corn in this country for feeding their own stock may be able to obtain larger outturns of grain on a given area by using the dent corns and the flint corns of America, but for those who grow maize for the market, the improvment of the two country varieties, and especially the lighter coloured one, must be the chief resource For such attempts as may be made towards adapting some of the American varieties to Indian conditions, it will be best to get the bright yellow varieties, and of them, as far as possible, those belonging to the flint class Here it may be mentioned that all these foreign varieties, when grown for some years in our climate, as a rule tend towards our normal type in all particulars—length of growing period, size of cob, colour, size and shape of kernels, &c This tendency, and the readiness with which the different varieties of maize cross, when grown side by side in adjoining fields are points in favour of those who wish to adapt superior American varieties to our local conditions, but these very points also serve as a warning against expecting too much in this direction and wasting time and energy which can be employed in improving the variety which we already possess, and which has yielded such excellent and quick results in return for the little trouble bestowed on it

If weighed and tested in April or May, when the weather and the cobs are driest, select good cobs of these varieties may be expected to yield the following results:—

—*Measurements of select good cobs of different size grown at the Cawnpore Station in* 1900.

Length of cob in inches	Circumference of cob in inches at—				Weight of cob in ounces	Weight of grain in ounces	Percentage of grain to cob	Actual number of grains in the cob	Number of grains to 1lb	Remarks
	Butt	Centre	Top	Average						
2	3	4	5	6	7	8	9	10	11	12
5½	5½	4½	5½	4⅝	2½	1¾	71·4	434	3,818	
6½	6	4½	3½	4⅜	2⅜	1⅝	71·4	409	3,482	
3½	6	5⅜	4⅜	5⅛	6½				*	
8	5½	5⅛	4⅜	5⅛	6¼	4⅞	78·0	699	2,055	
9					6⅜	5⅛	81·1		1,718	
8	5⅜	6½	4½	5⅝	7⅛	6⅜	84·1	654	1,579	
8½	5½	6½	4⅜	5½	8	6⅞	85·0	661	1,469	

had fallen, and so the weight of cob is lower than the real

ations given in the above table were made in such cobs as were available at the time, and the ood enough for forming general notions, are not to in deciding the merits of the three varieties as resent For purposes of comparison the follow- be taken as more truly representing the present ieties, assuming that the weighments are made in of North India :—

TABLE No. V.—*Length, weight, &c. of cobs of different varieties of maize as they stood in 1900*

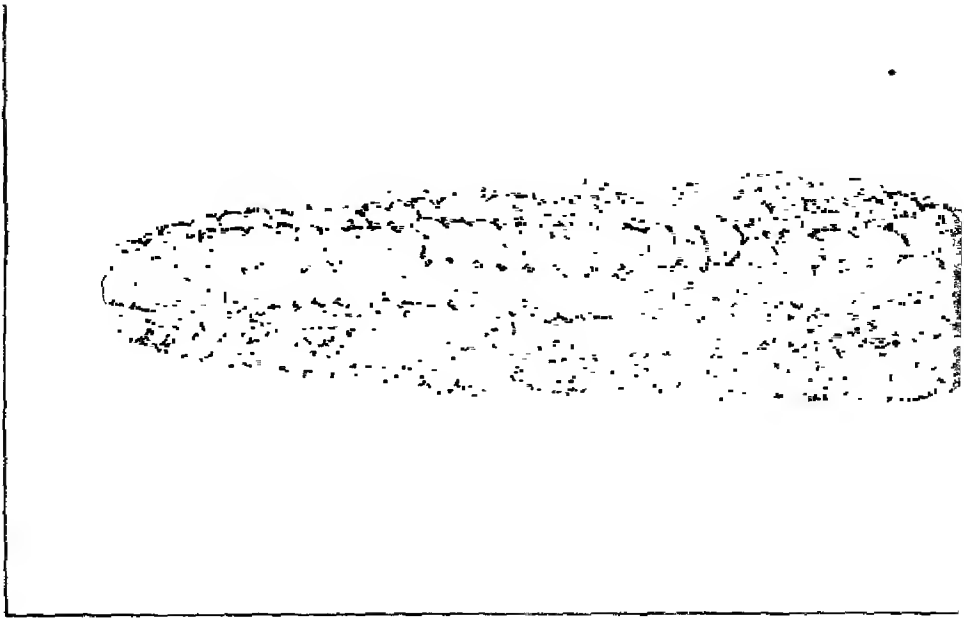
	Name	Length of good cobs in inches	Weight of average good cobs in ounces	Maximum weight reached by best cobs in ounces	Number of grains in lb of seed of good cobs	Remarks
1	Deep yellow country (grown by Cawnpore cultivators)	4 to 5 5	2 to 2 5	2 7 to 2 8	3,270	
2	Improved deep yellow country (grown at the Cawnpore Station)	5 to 6 5	2 5 to 4 5	4 5	2,720	Improvement by selection of seed, &c., was begun in 1896 but has not been prosecuted as well as it could be done
3.	Light yellow country (grown by cultivators in Meerut and Rampur side)	6 to 9	4 to 5 5	6 0	2,600	
4	Improved light yellow country (grown at the Cawnpore Station)	7 to 10	5 to 6½	7 7 to 8	2,412	Improvement by selection of seed, &c., was begun in 1896, and carried on more assiduously than with the other variety, but still not quite satisfactorily
5	Extra early Waterloo Dent Field Corn	6 to 8½	5 to 7	5 to 8 5	1,775	These were imported from America in 1897, and have been grown at the station since then, except in 1898. These figures refer to them gradually transformed stock in 1900
6	Blount's prolific Field Corn	6 to 8½	Ditto	Ditto	1,573	
7.	Red Flint Corn	Ditto	5 to 6½	7 7	1,896	
8.	Sugar Corn	4 to 7	3 to 5	6 0	1 969	

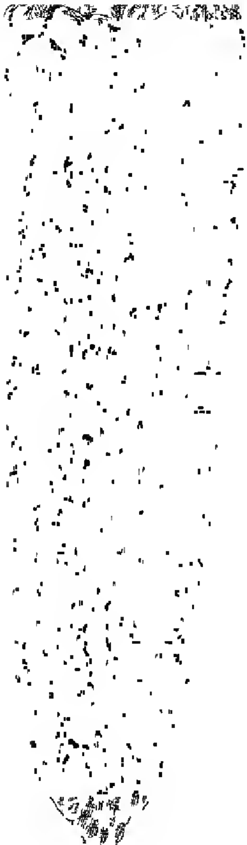
From these figures, especially from the weights of average good cobs and the maximum weights reached by the best cobs, it will be seen what degree of improvement has been effected on the two country varieties by selection of seed and better cultivation, and how in its present improved form the light yellow country variety is approaching the American field corns. The yields of grain, &c, obtained from these varieties in 1900 are given in the next table. Considering the fact that the improved light yellow country variety was allowed more room for each plant than what has been found to give the heaviest yields with it, and considering also that with the right spacing it has yielded on a number of plots outturns higher than 3,000lbs per acre in 1900, it may for our local conditions be safely assumed to have practically equalled the American field corns tried at Cawnpore

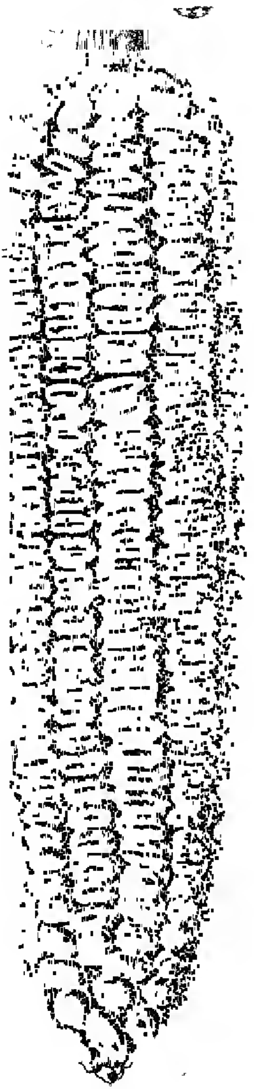
With reference to the percentages of grain to cobs given in table No IV above, it should be remembered that the proportion between grain and cob will vary according to the dryness of the cobs, the weight of the crop, and to a less extent the variety and size of the cobs Weighed at the time of harvest in September, all these varieties yield from 65 to 75 per cent. of grain in relation to the cobs and rarely more, but as the weather and cobs get drier the proportion rises, yielding about 82 to 83·6 per cent. in the case of Improved light yellow country and similarly with the other varieties. As regards the real difference in the proportions due to the intrinsic merits of the varieties at the depth of the grain, the smallness of the cobs &c., the figures in column 9 of table No. IV may be assumed to be fairly representative after adding about 1 per cent to the figures of the Improved light yellow country on account of its grains having been slightly injured by accidental causes.

TABLE No. VI.—*Acreage yields of dry grain, straw, &c., obtained from different varieties of maize grown at the Coimbatore Experimental Station in 1900*

Name of variety	Distance at which dibbled	Manure applied	Weight of grain per acre dry	Weight of shelled cobs	Weight of straw per acre dry	Remarks
			lbs	lbs	lbs	
1. American yellow Dent Field Corn	3' × 1½'	Poudrette at 250lbs nitrogen per acre	1,072	592	5,768	
2. Extra early Waterloo ditto	"		2,500	511	7,013	
3. Blount's Prolific Field Corn	"		2575	510	4,613	
4. King Philip ditto	"		1,913	478	10,025	
5. Sweet Corn	"		1,425	382	5,525	
6. Improved light yellow country maize	"		2,626	613	15,575	
7. Improved deep yellow country maize	2 × ½		1,963	450	9,875	







APPENDIX No I

Directions for selecting maize seed as practised at the Cawnpore Experiment Station, and likely to be of use to such persons of education as wish to carry on seed selection in a more scientific manner than that given on page 7.

First decide exactly what qualities you wish to develope and perpetuate. In maize the great point that needs working for is the largest weight of grain per plant

After a cursory examination of the standing crop of your fields, stout vigorous plants bearing two well-developed cobs should be marked out by tying a piece of tape or twine round the stem. For the forcing climate of North India, in which maize matures as a rule in 75 to 90 days, more than two cobs per plant are of no good for a field crop On subsequent examinations before the crop is cut fresh plants may be marked and added to the list of the selected plants, or some of those already marked may be removed from the list. In marking out, besides the main points already enumerated, short cob stalks, and cobs formed as near the ground as possible, may also be kept in view as desirable points

After the crop has been harvested the marked plants should be separately dried and weighed. The cobs on completely drying from the stalk should be separated, unsheathed and subjected to a closer examination. The main point for observation in this examination will be largest weight of cob yielding the largest weight of grain, so that the largest produce of grain may be obtained from an individual plant from out of both the cobs of the plant.

Subject to this main aim the points that should be observed are—

(1) Well-developed, large, plump grains

(2) Bright yellow colour dull coloured seeds have been found specifically lighter, and to bear a smaller proportion in weight to the cobs than the bright coloured grains: other colours are less common, not so popular, and perhaps not so hardy in India

(3) Weight for weight, shorter and stouter cobs to be preferred to thin and long ones.

(4) Cobs tapering as little as possible, *i.e.*, having their tips as little narrower as possible than thin butts, they should be nearly cylindrical.

(5) Cobs filled up to their very tips.

(6) Cobs in which the rows are straight and there are fewest blank spaces between the rows or in the rows themselves.

(7) The larger one of the two cobs of a plant

With these points in view choose the very best of the cobs already selected on the field In this final selection let not the aim be to select as many cobs as possible having more or less equally these good points, but it should be to secure a greatest combination of all these qualities in the highest possible degree. If you meet with only one such cob that will quite do. Before adding a second cob to it make certain that the second or third cob is in every way equal to the first, otherwise you introduce into your attempt of fixing in the race the highest combination of the good features an item of chance and room for the progeny to go down from that level of excellence. As many as about five to ten such very best cobs may be finally selected. They should be carefully preserved in pots (If obtainable, a little naphthaline put between them will help to preserve them from weevils.) At the time of sowing the seed at the tip and the butt of each cob may be left out and the rest carefully sown Having thus chosen the few cobs of greatest excellence for developing and perpetuating the variety, the remainder of the cobs of the marked out double-cobbed plants can be used as seed for the next year's general crop, for this purpose also using if possible only the better cobs and leaving out the inferior ones

These principles of selection should be observed continuously for a number of years, with a view to getting a variety possessing the highest possible excellence and productive capacity for our climate, soil, and requirements.

Number of plots	Area of each plot	Distance at which seed was dibbled	Number of cobs	Weight of cobs	Weight of grain	Average weight of each cob	Number of cobs to yield 1lb of grain	Remarks
1	2	3	4	5	6	7	8	9
		Light yellow country maize—		lbs	lbs.	Oz		Making due allowance for the disturbing factors, the figures tend to show generally that the larger light yellow variety does best when allowed 2 to 3 square feet for each plant and the other variety with 1½ square feet This is in accord with the general experience at the station.
1	242 sq yds	(2′ × 1′) "	15,400	3 429	2,780	1 5	5 5	
2	Ditto	(2½′ × 1′) "	16,280	3,700	3,005	3 6	5 4	
3	Ditto	(3 ′× 1′) "	12,880	34,800	2,730	4 0	4 7	
4	Ditto	(3½′× 1′) "	11,200	2,500	2,280	4 2	4 6	
5	Ditto	(3 ′×1½′) "	5,400	2,230	1,800	6 7	3 2	The plants on a certain portion of these two plots were weak, due to some disturbing factor, probably the portion having been poorer than the rest of the field
6	Ditto	(3½′×1½′) "	8,580	2,140	1,695	4 9	5 0	
		Deep yellow country maize—						
7	Ditto "	(1½′× 1′) "	20,000	2,580	2,110	2 0	9 4	
8	Ditto "	(2′ × 1′) "	15,700	1,940	1,629	1 9	9 6	
9	160 sq yds.	(2½′× 1′) "	12,100	1,936	1,535 5	2 5	7 6	
10	577 "	(3′ × 1′) "	10,986 5	1,610 5	1,316 9	2 6	8 1	